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OBSERVATIONS ON THE TIN MINES AT KO-CHIU, YUNNAN

Chu Ch'ung-t'ien

The Ko-chiu tin mine was discovered about the middle of the Ming Dynasty (1368-1644) and was worked in a desultory fashion, with no production to speak of until the time when it became flooded. There is no reliable record of this period of operation.

Near the close of the Ch'ing Dynasty (1644-1911) a so-called Tin Affairs Company was organized. This was the forerunner of the Yunnan Tin Industry Company. Later the name was changed to the Yunnan Tin Refining Company. In the autumn of 1940 it was reorganized into the present Yunnan Tin Company. This company was jointly organized by the Yunnan provincial-government-owned People's Industrial Company, the National Resources Commission, and the Bank of China. The total subscribed capital for the enterprise was only 50 million yuan. In 1946 the capital was raised to one billion yuan. The Yunnan government concern holds 40 percent of the capital interest and the National Resources Commission and the Bank of China 30 percent each. The company headquarters is at K'un-ming and the mine-management office at Ko-chiu.

Of the 3,800 persons now employed in production, 10 percent are skilled workers and the remainder are common laborers. In December 1947 the monthly income of the skilled workers was between 1,300,000 and 1,500,000 yuan per individual. Foremen-laborers received over 600,000 yuan and the common laborers, approximately 400,000 yuan.

The workmen board themselves and, since common laborers are a hearty diet, the pepper, capsicum and greens which are their regular fare are nutritionally insufficient. According to responsible persons, however, the present condition is a great improvement over the past. The workers now have meat on the second and sixteenth of each lunar month, and can buy cloth at reduced prices.

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Formerly the workmen were restricted in their movements. Should they run away and be captured, they became lifelong slaves, had to wear fetters, and were fed on the coarsest of food. Now they are at liberty to quit whenever they desire. Many of those who have worked for a considerable time or have developed more skill than others leave the company and pan tin for themselves or on contract for others, but many go into debt in this way.

The company endeavors insofar as possible to care for the interests of the laborers. It maintains a commissary, a hospital, and a school which are open to the families of the staff and the laborers at no cost to them.

The company maintains a staff of 180 members whose minimum individual income in December 1947 was over 2½ million yuan. This is equivalent to that of government employees of comparable rank in the area. The company pays transportation for families and furnishes living quarters. After a certain period of service, vacations may be enjoyed, with transportation paid to and from the individual's home place. It may be said that the treatment of the staff is generous. The employment is largely of life tenure and the company does not lightly make changes. It would appear that if the treatment of the common laborers could be bettered somewhat, production could be stepped up.

At the present time the company has one old and one new mine. The present yearly production of both is 1,400 tons of refined tin. This may in the future be stepped up by one-half. There are also an ore-separation plant, an electric machinery maintenance plant, a machine shop, a refinery, and a large coal mine located at Miao-ko. This mine supplies cooking coal, and the vein extends as far as the Hung Ho many miles away. It has sufficient reserves for 100-200 years. The annual production of coke from this mine, which is located in K'ai-yuan Hsien, is 1,500 tons.

With the revival of the tin industry in the South Pacific area the Yunnan Tin Company will be faced with a serious problem of competition. The tin in the South Pacific area is obtained by placer-mining methods and can be readily refined. Moreover, the equipment used is good. The annual prewar production was close to 100,000 tons (TN: Verified by U. S. Department of Commerce figures). At Ko-chiu, however, the tin is in ore veins and relatively more difficult and expensive to produce. They are unable to use wholly scientific methods, with resulting waste. The prewar production of both government and privately operated mines at Ko-chiu was not over 10,000 tons. At present it is only about 5,000 tons.

Because of the present preoccupation with the Indonesian independence movement, the Dutch-Indonesian authorities have been unable to give attention to the difficult task of restoration of the tin industry. Once this can be done the Indonesian tin industry will increase production and there will be a terrific struggle for the world tin market. This anticipated competition does not offer a bright outlook for the Ko-chiu mines. The government should be prepared for this prospect.

The two mines at Ko-chiu are in separate locations and are more than 10 km from the refinery, in mountainous regions at an elevation of more than 2,600 meters. The equipment of the old mine is better than that of the new. It has some 9 km of underground dump-car tracks and produces about one-half the total output of the company. Unfortunately, there is no cable-car line between this mine and the ore-selection and refinery plants. Consequently, antiquated methods of washing the ore are employed and water shortage, except in the rainy season, keeps down production. A stockpile of 90,000 tons of ore at the old mine awaits the installation of cable cars to transport it. The installation is now in process.

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The new mine is at Ma-la-ko, separated from the refinery by many mountain peaks. The engineers have tested their ingenuity to the li ways to connect these peaks by cables in order to transport the ore. They have succeeded in constructing  $4\frac{1}{2}$  km of such cable lines with about 100 cars installed. The cable-car system consists of two parallel steel cables  $1\frac{1}{2}$  inches in diameter, placed about 10 ft apart and supported on steel posts set in concrete. Below this runs an inch-thick steel cable which passes around two steel pulleys 7 ft in diameter which are located at the top and the bottom of the mountain. The ore cars are attached to this moving cable and suspended from the two parallel cables by three specially designed pulleys. The cars are thus drawn up and down the mountain. The power is supplied by electric motors. Each car can carry 1,333 pounds of ore and two men.

Beyond Lao-jen Shan is an especially long stretch of 2 km where the cable is quite slack. When the wind blows, the cars swing dangerously.

The tin at Ko-chiu is in ore veins. When it comes from the mine it is a mixture of ore-grain-impregnated yellow clay. It must be washed free. This process is carried on in the ore-separation plant.

The chief feature of the ore-separation plant is a five-story steel-frame building covered with galvanized iron sheeting. It was built by the original Ko-chiu company under the supervision of an American engineer. During the recent war it was a target for Japanese bombs, but no great amount of damage was done. The source of power is an electric power station, but since this is too small, additional power is supplied over high-tension wires from K'ai-yuan over 70 miles away.

At the beginning of the separation process the ore is brought up to the fifth floor and dropped onto a large metal sieve. The fine material drops through the sieve to the fourth floor. The workmen throw the coarse rock and hard clay into the crushers where it is pulverized. This material is then hydraulically washed into revolving drums one meter in diameter and three meters in length in which are a number of iron beaters constantly in motion. Here it is mixed with water to the consistency of a thick, soupy liquid. The liquid then flows down to the third floor shaker sieves which are constantly in motion. A stream of running water passes through the sieves. The light clay goes into suspension and flows off with the water. The heavier ore-bearing elements sink and run off through sluices into wooden vats. The tin content of this latter residue is approximately 80 percent. As it settles in the vats it is dark gray in color and has a high specific gravity.

The other material, containing mixed elements, is once again processed through the third floor and on to the second and finally to the first floor shaker sieves. The residue becomes continuously finer until what remains contains only one-half to seven-tenths of one percent of tin. For further refining of this residue, machines are ineffective and it is run into vats where hand labor is employed to stir and settle it. The settleings are then placed in specially constructed bevel-sided vats where they are sprayed to further separate the light and heavy elements. Eventually the final residue is placed in large iron kettles which are filled about nine-tenths full of water. At this point experienced laborers use brooms to agitate the water, meanwhile shaking the kettle with a vibrating motion for about an hour. The light material floats, the heavy sinks. The upper part of the residue is removed and the lower part will then contain 60 percent or more of tin. This is the final operation.

The ore-separation plant has two sets of machines of which one set is operated at a time. With only three men to control them, these machines can

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process 200 tons of ore a day for a tin production of about 2½ tons. A hundred men could not accomplish this result without this equipment. At the old mine and in private operations the use of human or animal labor costs more and yields poorer results.

The manager of the refinery explained that the smoke issuing from the blast furnace contains one percent of tin which disappears without trace. This blast furnace was designed to use Niao-ko coking coal, but due to faulty equipment, pine charcoal is used instead. Its heat production is insufficient and the cost high. The ash contains one-half of one percent of tin. For greatest efficiency an electric furnace is desirable, but its transport into the area constitutes a most baffling problem, nor is the present available electric current sufficient to operate it.

The blast furnace has a capacity of 10 tons of ore. The first smelting does not result in pure metal. It must be resmelted in order to completely eliminate extraneous elements such as iron, lead, zinc, bismuth, etc. The laborers then ladle it into 50-kg ingot molds which completes the refining process. The ingots must be of 99 percent fineness before they can be exported. In order to ensure the maintenance of this standard, assays are made at Hongkong before export abroad.

The annual production of the private mines, amounting to about 3,000 tons annually may be freely sold without restriction, but the company's production must be disposed of through government agencies.

The ore-bearing clay is all dug from shafts, some of which in the new mine are as much as 5,670 ft deep. One noted private mine on Huang-ya Shan is 4,570 ft deep.

The ore veins, and consequently the shafts, are very crooked. Since there are no strict regulations governing the subsurface digging, there are frequent altercations among the workmen when their diggings run together. When machinery is used, 60 meters may be dug in a month, but by hand only 8 or 9 meters. The company has sufficient machines, but insufficient electric current to operate all of them.

In the government mine working conditions are better than in the private enterprises. The government mine has electric lights, elevators, rail lines at various levels, and forced-draft ventilation.

In the private workings there is great lack of many necessary items of equipment. Shoring timbers are in short supply. Cave-ins resulting in frequent deaths to miners are common. The shafts are so small that youths must be employed to do the digging and as many as 90 percent of the miners are of this class. They are deprived of sunlight, fresh air, and water to the great detriment of their health. Most of them become walking skeletons. The treatment they receive at the hands of their employers depends entirely upon the employers' dispositions or whims. According to recent reports the Social Affairs Department of the Yunnan provincial government has been investigating these conditions. If salutary changes can be instituted, many potential citizens may be saved to society.

The current market value of tin is 145 American dollars for 110.23 pounds.

This tin-mining project should not be neglected by either government or private capital. Every effort should be made to increase production.

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